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The Development and Performance of TEAM ALFALFA

A Multiple Pest Resistant Alfalfa with Moderate Resistance to the Alfalfa Weevil

Agricultural Research Service
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THE DEVELOPMENT AND PERFORMANCE OF TEAM ALFALFA: A MULTIPLE PEST RESISTANT ALFALFA WITH MODERATE RESISTANCE TO THE ALFALFA WEEVIL[1]

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SUMMARY

Team is a vigorous growing variety with moderate resistance to the alfalfa weevil, anthracnose, Stemphylium leaf spot, common leaf spot, and high resistance to pea aphids. It was developed for the Maryland-Virginia-North Carolina area. The first certified seed of Team alfalfa will be available for spring planting in 1970. This publication makes pertinent information on performance of the new variety available to extension and research personnel, and to prospective growers.

Team alfalfa was released jointly by the U.S. Department of Agriculture and the cooperating Agricultural Experiment Stations of Maryland, North Carolina, and Virginia in February 1969. Team represents progress in development of host plant resistance for control of the alfalfa weevil, the most serious insect pest to attack alfalfa in Eastern United States. Breeding alfalfa resistant to the alfalfa weevil has been one of the most difficult objectives undertaken in alfalfa breeding.

Team is a product of more than 10 years of research. Its name acknowledges team effort among alfalfa workers in Agricultural Research Service and the three State agricultural experiment stations. Team's multiple pest resistance and desirable agronomic traits will provide growers with higher yields, longer lived stands, and lower insect and disease losses than presently obtained with other varieties.

---

[1] Joint contribution from the Crops and Entomology Research Divisions, Agricultural Research Service, U.S. Department of Agriculture, and the North Carolina, Maryland, and Virginia Agricultural Experiment Stations.

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The search for weevil resistance was extensive. All available varieties, strains, and introductions of alfalfa were collected and tested for weevil resistance; but high resistance to larval feeding was not found. Briefly, the breeding procedure used to develop Team consisted of isolating the best kinds of resistance available, intensifying resistance by recurrent selection procedures, and combining this trait with desirable agronomic characteristics and with resistance to other pests. There were six cycles of selection for weevil resistance. Four of the six cycles of selection were conducted in the field--two each in North Carolina and Maryland. The fifth and sixth cycles of weevil selection were conducted in the greenhouse and laboratory at Beltsville, Md. From 2,500 to 50,000 plants were evaluated in each cycle. The alfalfa weevil resistance of Team has been attributed to a combination of mechanisms including tolerance, nonpreference to adult feeding and oviposition, and larval antibiosis.

The resistance of Team is not high enough for the variety to be the ultimate answer to the weevil problem, but it represents a positive improvement. Growers can expect to see weevil feeding on Team. Damage, however, will usually be less than on other varieties. Under light to moderate infestations, Team may produce a good first cutting of forage without insecticidal control. During 1968 and 1969 in Maryland, infestations were light and Team did not require insecticide treatments for practical control. If weevil populations in Maryland continue to remain low and parasites continue to be active, it is conceivable that insecticide treatments on Team may seldom be necessary. However, growers are advised to inspect fields frequently throughout the weevil season. In Virginia and North Carolina the need for insecticides will be reduced, but it will probably be necessary to use one or more insecticide applications before harvest of the first cutting.

A moderately weevil resistant variety like Team should be used as a part of an integrated control program including good crop management and judicious use of insecticides when necessary. It is assumed that less frequent use of insecticides will result in greater numbers of predators and parasites, thereby improving biological control of the weevil.

INTRODUCTION

The alfalfa weevil, Hypera postica (Gyllenhal), is the most important and destructive insect pest of alfalfa, Medicago sativa L., in the Eastern United States. Blickenstaff (1967)[9] reported that the loss from weevil feeding in yield alone was about \$56 million in 1966. Additional losses to growers of \$14 million occurred as a result of spray costs for control. Other losses noted were the reduced alfalfa acreages in Eastern and Southern States and the cost of surveillance of insecticide residues in meat and milk products.

The alfalfa weevil was first detected near Salt Lake City, Utah, in 1904 (Titus, 1907). It has since been reported in 45 States (fig. 1). Its dispersal was confined to an area west of the Mississippi River until 1951 (fig. 2) when it was detected near Baltimore, Md. Since that time, spread

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[9] See Literature Cited, p. 40.

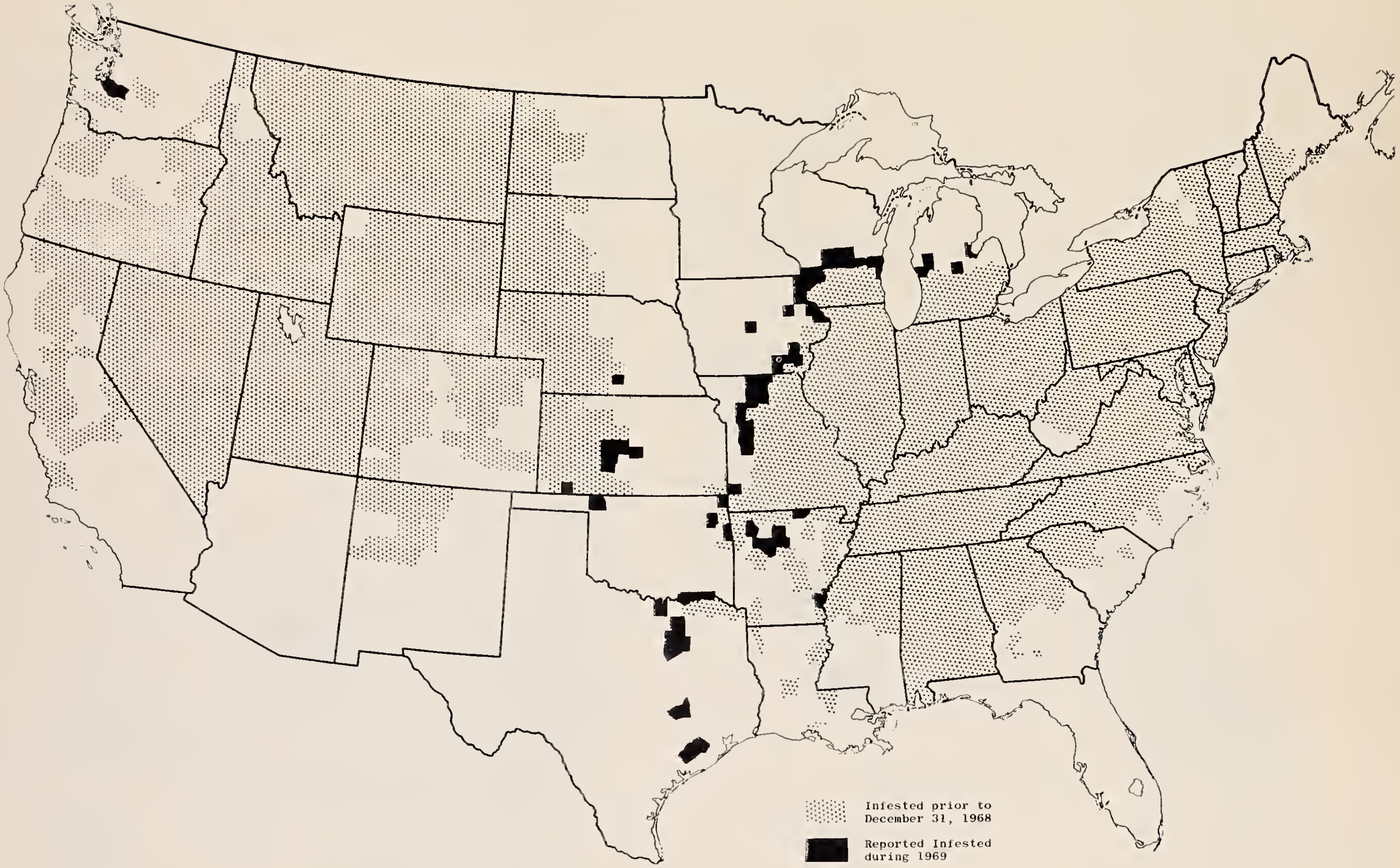
Infested prior to December 31, 1968
Reported Infested during 1969

Figure 1.--Distribution of the alfalfa weevil in the United States in 1969. (U.S. Department of Agriculture, 1969b, p. 533.)

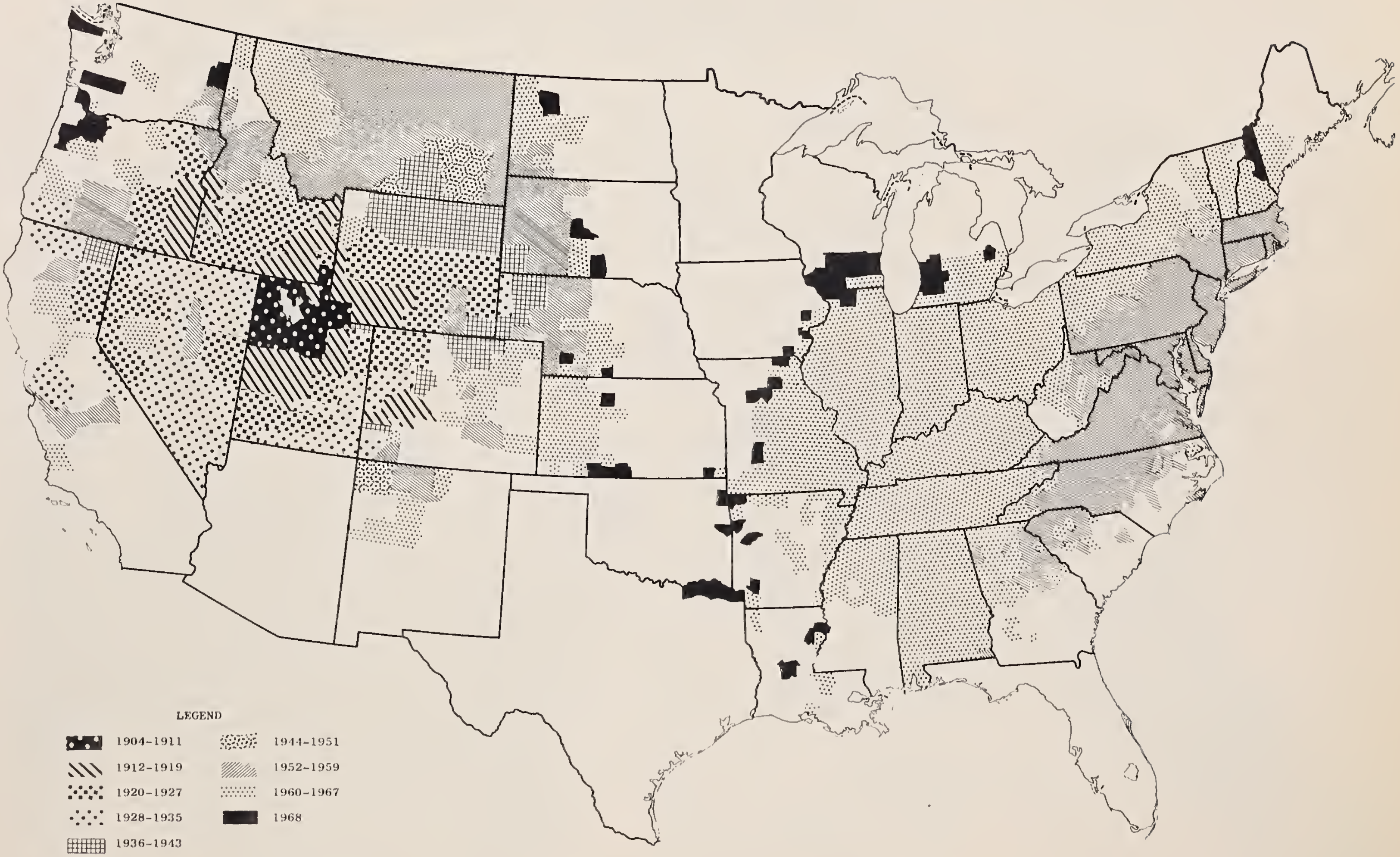

Figure 2.--Spread of the alfalfa weevil in the United States, 1904-68. (U.S. Department of Agriculture, 1969a, p. 154.)

throughout Eastern United States was relatively rapid. Major concern now is centered on its continued spread and development in the high alfalfa producing areas of the North Central States.

The greatest decline in alfalfa acreage associated with the alfalfa weevil occurred in the Mideastern States. There alfalfa acreages were relatively small; nevertheless, the impact on agriculture was significant. U.S. Department of Agriculture (1960 and 1968) figures (table 1) show that the alfalfa acreage in Maryland, Virginia, and North Carolina declined 38, 70, and 86 percent, respectively, since 1958, when the weevil became generally established.

TABLE 1.--Reduction in alfalfa acreage in Maryland, Virginia, and North Carolina from 1958 to 1967

State	1958	1967	Reduction
	Acres	Acres	Percent
Maryland	113,000	70,000	38
Virginia	269,000	82,000	70
North Carolina	79,000	11,000	86

Source: 1960 and 1968 editions of Agricultural Statistics, U.S. Department of Agriculture.

Several methods are used to control this pest, although insecticides remain as the most important means of control in areas where the weevil problem is severe. Information on currently recommended insecticides is available from your local county agent or State agricultural experiment station. Before the advent of modern insecticides, numerous mechanical and cultural methods of control were suggested. Mechanical measures, such as experimental flaming (Titus, 1910; Webster, 1912), and cultural and management practices, such as flooding, brush dragging, disking, harrowing, and pasturing (Essig and Michelbacher, 1933), were tried with varying degrees of success. More recently, research with flaming has been conducted in the Eastern United States, particularly in southeastern areas where overwintering eggs are a major source of spring larval populations. In these areas, flaming of alfalfa during the dormant stage (fall or late winter) reduced weevil damage by delaying the onset of larval feeding but did not provide adequate control over the entire period of first crop development.

Biological control measures against the weevil were initiated in Utah in 1911 with the introduction and release of a larval parasite, _Bathyplectes curculionis_ (Thomson), a minute wasp, native to Europe. This species spread and established in the weevil-infested area either naturally or by colonization (Clausen, 1956). First efforts toward biological control in the Eastern United States were conducted with _B. curculionis_ from 1953 through 1955 in Delaware and Maryland. This species was successfully established in the East in 1959 (Puttler, Jones, and Coles, 1961). Since that time several other larval and adult parasites of the weevil have been widely released and are now established in a number of States--primarily in the Eastern States. By 1968 more than 300 releases of 10 species of parasites had been made in 20 States (Brunson and Coles, 1968). Five of the species have been recovered and are known to be established. These include the larval parasites *B. curculionis*, *B. anurus* (Thomson) and *Tetrastichus incertus* (Ratzeburg), and the adult parasites *Microctonus aethiops* (Nees) and *M. colesi* Drea.

The ultimate role and importance of biological control in the overall control of the weevil is still unknown. *B. curculionis* has been reported to be of considerable importance in biological control in the western range of the weevil and may contribute to differences in severity of the weevil problem in Eastern and Western United States. Recent declines in alfalfa weevil population levels in the Middle Atlantic States, where biological control efforts have been concentrated since the 1950's, indicate that parasites are becoming a factor in suppressing this pest in its eastern range.

HOST PLANT RESISTANCE

About 10 years ago breeding research was initiated to develop plant resistance to the alfalfa weevil. Host plant resistance when it is attainable offers an excellent solution to insect pest problems. Resistance avoids problems associated with the use of insecticides and permits greater development of predators and parasites. With presently available levels of resistance to the alfalfa weevil, plant resistance and biological control, together with judicious use of insecticides, offer the best long-range solution to the alfalfa weevil problem.

The ease with which resistance can be developed in a breeding program varies greatly with the pest and crop involved. Breeding alfalfas resistant to the alfalfa weevil was one of the most difficult objectives undertaken in alfalfa breeding. There were two principal reasons. First, none of the hundreds of alfalfa varieties and introductions that were evaluated in the ARS or State programs were found to have suitable resistance to larval feeding. Second, handling plants and insects on the large scale required was laborious and costly.

The first published information on differential response of alfalfa strains to weevil infestation was based on observations made in 1957 in North Carolina by Dogger and Hanson (1963). They evaluated 294 experimental and commercial varieties as sources of host plant resistance in field tests. Significant differences in susceptibility were noted, but none was sufficiently resistant to provide satisfactory control of the weevil. Differences in field resistance were also observed when more than 400 alfalfa introductions were evaluated in Pennsylvania, Maryland, and North Carolina (Busbice, Barnes, Hanson, and others, 1967). Again, differences among strains were apparent but none of the introductions appeared to have levels of resistance of economic significance. The low levels of resistance noted usually appeared to be associated primarily with morphological traits such as small stems.

Detailed field studies by Norwood, VanDenburgh, Hanson, and Blickenstaff (1967) indicated that approximately 25 percent of the variation among alfalfa clones for larval feeding damage was associated with oviposition preference. Plants with decumbent growth, nonvigorous spring growth, and small stems received the fewest eggs and suffered least larval feeding. Although stem diameter was positively correlated with oviposition, some clones with medium to large stems received only a few eggs. The authors concluded that selecting plants with low oviposition preference and large stem diameters had some potential for developing agronomically acceptable varieties with resistance to the weevil.

At Beltsville, Md., four laboratory and greenhouse screening tests were devised for isolating resistance to different stages of the life cycle of the alfalfa weevil. The tests were used as successive steps in each cycle of selection (fig. 3). From 10,000 to 50,000 seedlings were used in the beginning of each cycle. At the end of each cycle, about 150 of the most promising plants remaining in the last test were selected for initiating a new cycle. In late April of each year, promising plants were sent to O. J. Hunt and R. N. Peaden, Reno, Nev., for seed increase under cage. Part of the seed obtained was fall seeded in the field at Raleigh, N.C., for spring evaluation of weevil feeding. The remaining seed was returned to Beltsville, Md., for initiation of a new cycle of selection.

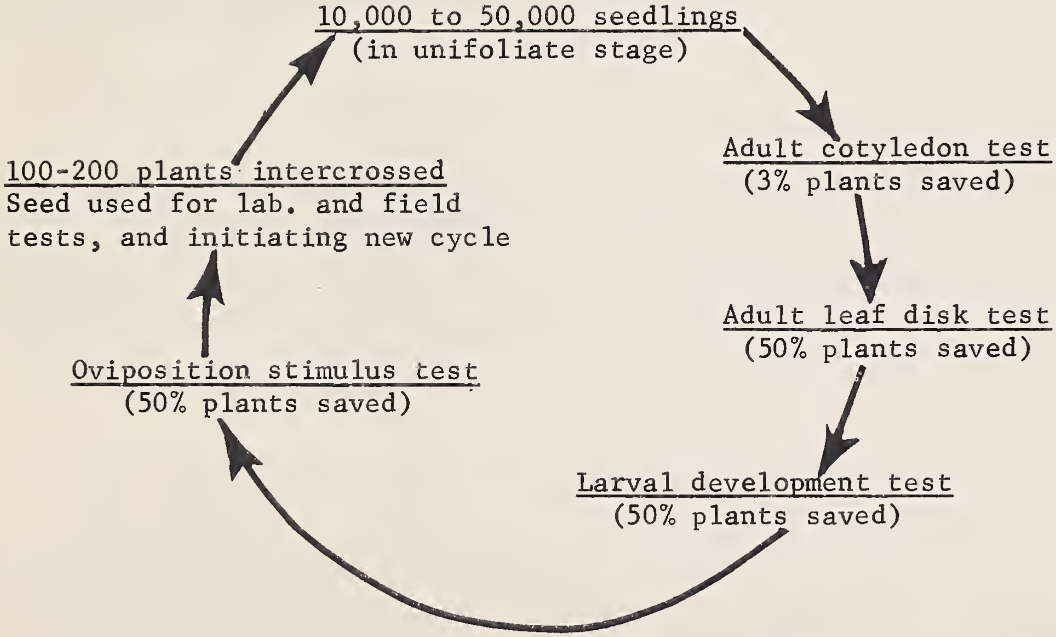

Figure 3.--One cycle of laboratory and greenhouse selection for alfalfa weevil resistance, Beltsville, Md.

The four tests used in a cycle of selection in the Beltsville program are given below:

Test of Cotyledon Nonpreference

In this test, 8-day-old seedlings were infested with adult weevils for a period of about 72 hours at the rate of 300 weevils per 1,000 seedlings (Barnes, Norwood, Hanson, and others, 1969). The least damaged seedlings were transplanted to 3-inch clay pots and tested in a forced adult leaf feeding test.

Leaf Disk Test

This test consisted of collecting 6 to 10 trifoliolate leaves from each plant; cutting 30 to 35 0.6-cm. leaf disks; and placing 10 leaf disks in each of two plastic dishes containing moistened filter paper (Barnes and Ratcliffe, 1967). The two dishes of each plant were each infested with four adult weevils for 16 hours. A third dish of 10 leaf disks was ovendried and the dry leaf disks weighed to the nearest 0.1 mg. The amount of feeding was determined by calculating percent area of leaf disks eaten by adult weevils and converting this to milligrams dry leaf weight eaten per four weevils. Plants having the least adult leaf feeding were saved and tested for larval development.

Larval Development Test

The procedure for this test was developed by Ratcliffe and Barnes.[10] It includes placing 10 newly hatched larvae on each plant, caging the plant with a plastic cage, and counting and weighing the larvae after 8 days. The interrelationships between the cotyledon, adult feeding, and larval development tests were described by Barnes, Ratcliffe, and Hanson (1969). Plants selected by the cotyledon test had slightly less adult feeding and smaller larvae than unselected plants from the same variety. Plants with the smallest larvae were tested for lack of an oviposition stimulus.

Oviposition Stimulus Test

The oviposition stimulus test was based on the observations by Byrne, Blickenstaff, Huggans, and others (1967) that some clover species lacked or contained only low concentrations of an oviposition stimulant. Weevils feeding on these clover species either failed to oviposit, or their oviposition was significantly reduced. A survey of annual *Medicago* species by Barnes and Ratcliffe (1969) indicated that some entries within the genus apparently lacked or contained only low concentrations of an oviposition stimulus. The method of testing for the presence of a stimulus consisted of maintaining four female weevils on excised stems of a plant to be tested before the test period. During this period of feeding, stimulus acquired by the weevil from previous feedings was dissipated. After 4 days of preconditioning, three of the weevils were transferred to two or three stems of the same plant on which they had been preconditioned. After 3 days the weevils were removed and the number of eggs deposited in the stems was recorded as number of eggs laid per weevil in 3 days. Plants receiving the fewest eggs per weevil were saved.

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[10] Unpublished data of cooperative investigations between Entomology and Crops Research Divisions, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, Md.

A fifth test, one for isolating nonpreference to oviposition (egg laying), has been used at Raleigh, N.C. The first laboratory procedure developed for isolating resistance was for isolating plants with low oviposition preference (Campbell and Dudley, 1965; VanDenburgh, Norwood, Blickenstaff, and Hanson, 1966; and Norwood, Barnes, VanDenburgh, and others, 1967). Busbice, Campbell, Rawlings, and others (1968) later refined this procedure for use in a recurrent selection program. Briefly, Busbice caged 120 plants in a 107 $cm.^2$ x 46 cm. high cage, infested the caged plants with 600 field-collected adult weevils, and allowed the weevils to oviposit for 2 weeks. Stems on each plant were split and the number of eggs and size of stem recorded. Low oviposition preference was usually associated with small stem diameter, but selection for low oviposition and large stems was effective to some degree.

DEVELOPMENT OF TEAM ALFALFA

Team is the product of six cycles (generations) of phenotypic selection for weevil resistance, vigor, and minimal damage from disease and insect pests. Four of the six cycles of selection were conducted in the field--two each in North Carolina and Maryland. The fifth and sixth cycles of selection were conducted in the greenhouse and laboratory at Beltsville, Md.

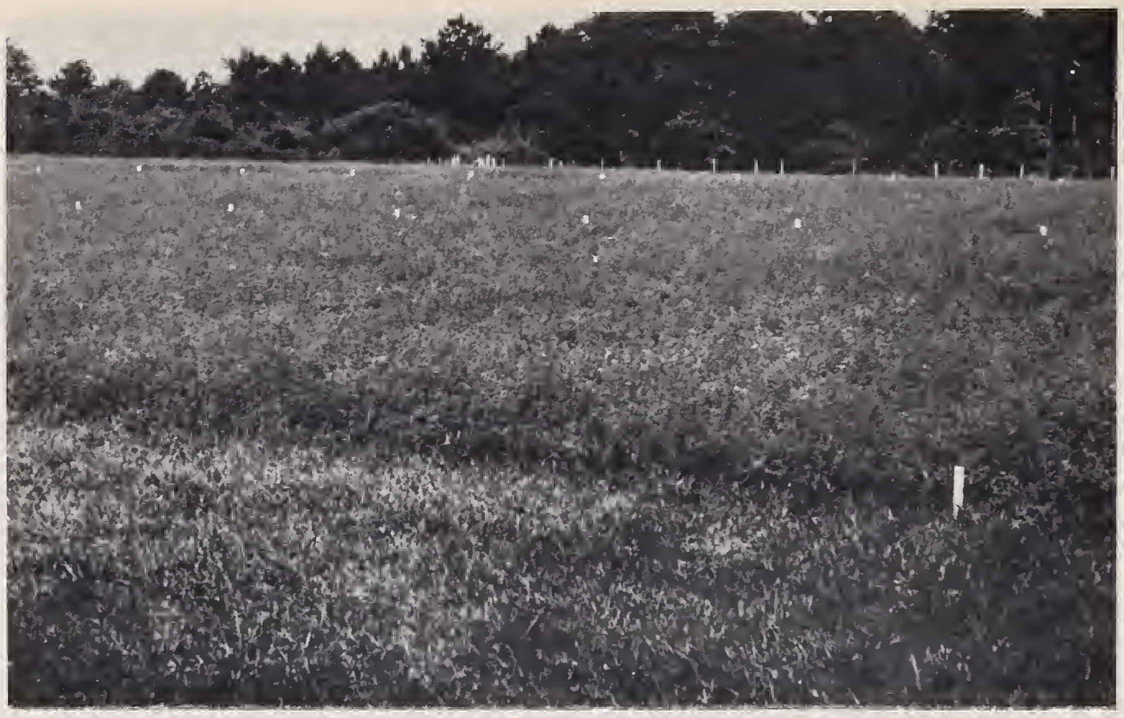
Parentage

Parentage of Team traces to 87 plants selected for low weevil larval damage in 1957 near Raleigh, N.C., by C. H. Hanson. These plants were from 2 acres of small broadcast plots of experimental lines after the alfalfa weevil had destroyed most of the forage (fig. 4).

More than half of the 87 plants traced to polycrosses and synthetics obtained in 1946 from Kansas and Nebraska breeding programs. The remainder came from Atlantic, DuPuits, Narragansett, and Rhizoma.

Cycles 1 and 2

The selected plants were designated MSHp1 (Mass Selection _Hypera_ _postica_ 1st cycle of selection) and intercrossed. The intercrossed seed was designated MSHp2. The progenies of 66 of the 87 MSHp1 plants were seeded in rows



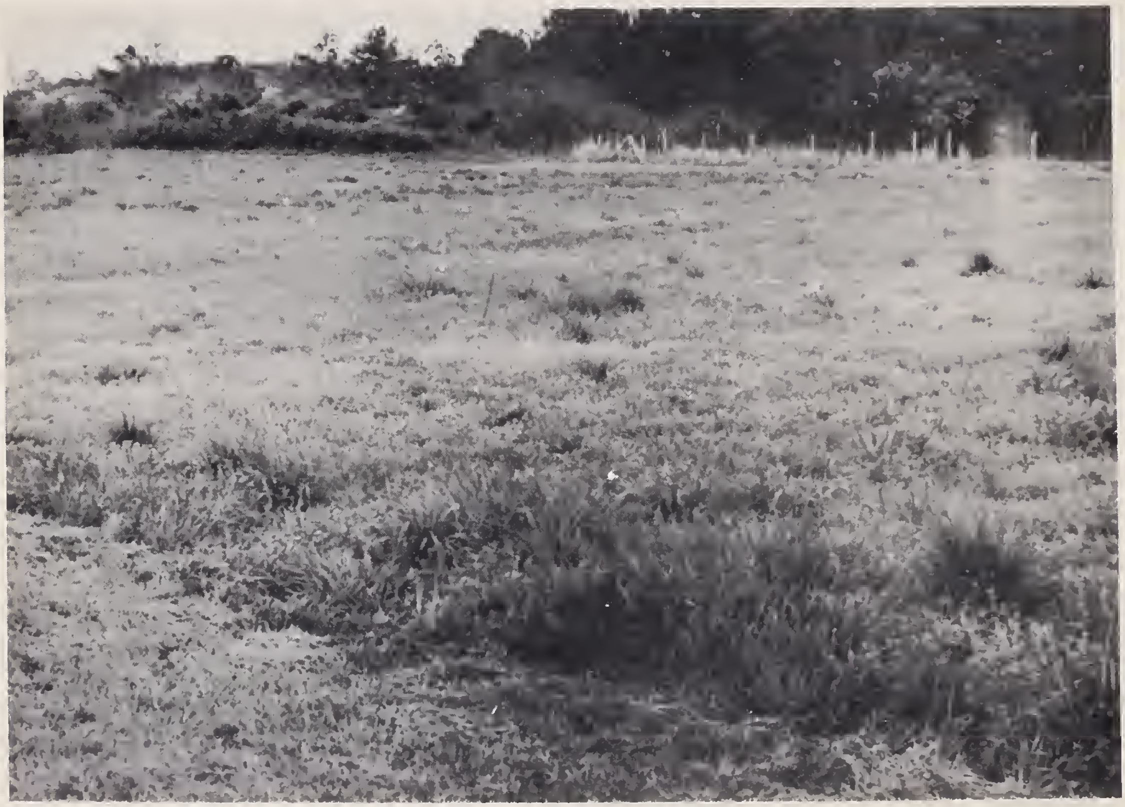


Figure 4.--Above, alfalfa test site at Raleigh, N.C., in 1956, showing vigorous growth of alfalfa. Below, approximately the same area 1 year later. The difference in growth of the alfalfa in the two photographs was attributed to the alfalfa weevil. The clumps of taller vegetation were volunteer plants of tall fescue, which were not attacked by the alfalfa weevil.

in a field test near Raleigh and scored for alfalfa weevil damage during the spring of 1958. The best plants within each of the 66 polycross lines were intercrossed to produce 66 maternal lines that were designated MSHp3 seed.

Cycles 3 and 4

The third and fourth cycles of selection were conducted in the field at Beltsville, Md. In the third cycle, the 66 maternal lines of MSHp3 seed were scored for larval damage during a 2-year period. Twenty-three plants of MSHp3, representing 15 of the original 66 lines, were selected and intercrossed. MSHp4 seed was obtained by bulking equal amounts of seed from each of the 23 selected clones. Approximately 2,500 MSHp4 plants were established in the field and observed for weevil damage during the spring of 1964. Ninety-six plants were selected and intercrossed to produce MSHp5 seed.

Cycles 5 and 6

In the fall of 1965, laboratory screening of MSHp5 seedlings was initiated by subjecting 8,000 seedlings to the cotyledon test. About 300 plants which were least preferred by the adult weevil were saved and tested for larval development. The 60 plants having larvae with the lowest weight and survival were intercrossed to produce MSHp6 seed. During the fall of 1966, approximately 46,000 MSHp6 seedlings were screened through the cotyledon test; 1,382 of the least preferred plants were saved for the leaf disk test. Of those plants, 794 were selected and evaluated for larval development. The 145 plants showing the poorest larval development were intercrossed to produce MSHp7 seed.

Significant improvement in weevil resistance of MSHp5 was observed during the spring of 1966 in a field planting at Beltsville, Md. Field and laboratory data on subsequent cycles in North Carolina confirmed that observation.

Seed Increase for Testing

Steps were taken to produce seed for large-scale testing and for use as breeder seed in the event of variety release. For that purpose, C. M. Rincker transplanted approximately 10,000 plants of MSHp7 during the spring of 1967 in a 3/4-acre field at Prosser, Wash. Seed from that planting was distributed to scientists in 19 States for experimental tests.

Release

The many desirable attributes of this population, including its moderate level of weevil resistance, prompted officials of U.S. Department of Agriculture and the North Carolina, Maryland, and Virginia Agricultural Experiment Stations to initiate plans for a joint variety release. In December 1968, the variety was favorably reviewed by the National Certified Alfalfa Variety Review Board. It was named Team to acknowledge cooperative efforts of alfalfa workers in Agricultural Research Service and the State agricultural experiment stations. A joint release statement was issued by the four cooperating agencies on February 17, 1969.

Seed increase of Team is accomplished on a three-generation basis: breeder, foundation, and certified. Breeder seed production is under the supervision of the Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture. Sufficient breeder seed has been produced from the 3/4-acre field at Prosser, Wash., to meet anticipated needs. Foundation seed is produced only from breeder seed and is the responsibility of the National Foundation Seed Project. The area of adaptation for production of foundation seed is defined as that north of 40° latitude at elevations below 3,500 feet in California, Nevada, Oregon, Idaho, and Washington.

Some certified seed will be available in commercial seed channels for spring planting in 1970. The U.S. Department of Agriculture has no seed available for distribution.

PERFORMANCE CHARACTERISTICS OF TEAM

Resistance to Alfalfa Weevil

Team has a moderate level of resistance to the alfalfa weevil. It is more resistant than previously available varieties in the Middle Atlantic States. The improved resistance of the Team population became apparent in 1966 in a field planting at Beltsville, Md., and in 1967, 1968, and 1969 in field tests at Raleigh, N.C. (tables 2, 3, and 4). This superiority was again noted in most of the tests conducted in eight other States during 1969 (table 4).

Greater first cutting yields of Team compared with other varieties in North Carolina (see section on hay yields) were attributed largely to its resistance to the alfalfa weevil. In New York, the contribution of resistance to increased yield was estimated by applying an insecticide to control weevil damage and comparing yields of treated and untreated plots. The application of an insecticide to control weevil damage increased the yield of Team less than that of more susceptible varieties (table 5). In that study, insecticides increased the hay yield of Saranac, Cherokee, and Vernal by 0.92, 0.84, and 0.78 tons per acre, respectively, compared with only 0.35 tons for Team.

Growers can expect to see weevil feeding on Team. Damage, however, will usually be less than on other varieties. Under light to moderate infestations, Team may produce a good first cutting of forage without insecticidal control. During 1968 and 1969 in Maryland, infestations were light and Team did not require insecticide treatments for practical control. If weevil populations in Maryland continue to remain low and parasites continue to be active, it is conceivable that insecticide treatments on Team may seldom be necessary. However, growers are advised to inspect fields frequently throughout the weevil season. In Virginia and North Carolina the need for insecticides will be reduced, but it will probably be necessary to use one or more insecticide applications before harvest of the first cutting.

Varieties with good spring vigor and large stem terminals, such as Saranac and others derived from Flamande alfalfa, tolerate weevil feeding early in the season and show less defoliation than the less vigorous varieties. However, by harvest even the vigorous varieties may be defoliated just as the less vigorous varieties (tables 2 and 3). Good spring vigor seems to depress weevil damage but cannot be relied upon as a means of control.

TABLE 2.--Defoliation of alfalfa varieties by alfalfa weevil larvae in field test No. A-160, 1967 and 1968, Raleigh, N.C.

	Percentage of foliage eaten by alfalfa weevil larvae							
		1968						
Variety	4-4-67	4-1	4-4	4-8	4-10	4-12	4-15	4-29
MSHp6[1]	35	8	17	21	30	26	32	54
Atlantic	77	10	25	34	43	49	60	89
Buffalo	87	11	28	39	47	50	61	94
Cherokee	61	8	17	25	32	39	48	85
DuPuits	77	8	20	31	28	40	50	82
Vernal	46	12	30	39	47	53	60	75
Williamsburg	75	11	25	36	53	50	61	89
L.S.D. (0.05)	20	3	5	9	10	9	4	14

[1] MSHp6 = generation before MSHp7 (Team).

TABLE 3.--Defoliation of alfalfa varieties by alfalfa weevil larvae in field test No. A-170, 1968, Raleigh, N.C.

	Percentage of foliage eaten by alfalfa weevil larvae			
Variety	4-8-68	4-12-68	4-15-68	4-29-68
Team	5	22	36	48
Atlantic	4	23	28	77
Cherokee	5	23	28	77
DuPuits	6	23	42	67
Vernal	5	24	43	75
Williamsburg	7	29	49	86
L.S.D. (0.05)	1	2	8	12

TABLE 4.--Alfalfa weevil damage scores for alfalfa varieties at 10 locations in 1969

	Beltsville, Md.[1]		Clarksville, Md.[1]	Blacksburg, Va.[2]	Raleigh, N.C.[3]			Knoxville, Tenn.[4]	State College, Pa.[1]	Wooster, Ohio[1]	Bedford, Ind.[5]			Logan, Utah[6]	Reno, Nev.[6]
Variety	5-16	5-22	6-6	5-28	4-23			5-13	6-12	6-12	5-22	5-28	6-3	6-11	6-3
Team	4.2	4.8	2.7	1.4	4.5	2.8	4.5	5.2	4.4	5.0	3.5	5.2	4.0	2.2	2.5
Atlantic	5.0	5.3	--	2.1	8.7	6.8	--	8.8	--	4.6	6.6	7.2	5.6	2.2	3.8
Cherokee	6.3	7.2	5.6	2.8	8.5	6.0	6.2	7.5	5.0	5.0	6.0	8.4	6.4	1.6	2.6
DuPuits	--	--	--	--	8.8	5.5	6.2	--	--	--	--	--	--	--	--
Saranac	4.5	4.7	5.0	1.1	--	--	--	7.0	5.6	4.0	4.0	7.3	6.5	1.8	--
Vernal	6.0	5.7	--	1.9	9.0	8.0	--	7.5	6.0	3.8	6.5	7.3	5.0	2.8	--
Weevlchek	5.5	5.5	--	--	--	--	--	8.5	--	--	5.0	6.6	4.8	--	--
Williamsburg	4.3	5.3	5.3	3.4	8.3	7.0	--	8.6	--	--	--	--	--	--	--
L.S.D. (0.05)	1.2	1.6	1.4	.7	1.0	1.4	--	1.0	.8	N.S.	1.8	1.2	1.0	N.S.	1.1

[1] Scored 1-9: 1 = least and 9 = most damage.

[2] Scored 1-10: 1 and 10 representing 10 and 100% defoliation, respectively.

[3] Test Nos. A-160, A-170, and A-174, respectively. Scored 0-10: 0 and 10 representing 0 and 100% defoliation, respectively.

[4] Scored 0-10: 0 = no damage and 10 = complete defoliation.

[5] Scored 1-9 by 3 individuals, 5-22-69 (2 = 25% and 8 = 55% defoliation), 6-3-69 (4 = 25% and 7 = 85% defoliation).

[6] Scored 1-5: 1 = least and 5 = most damage.

TABLE 5.--Total seasonal hay yields of alfalfa varieties with and without insecticide control of alfalfa weevil larvae, 1969, Ithaca, N.Y.

Variety	Hay yield, tons per acre		
	Control[1]	No control	Difference
Team	5.77	5.42	0.35
Vernal	5.43	4.65	.78
Cherokee	5.87	5.03	.84
Saranac	6.46	5.54	.92

[1] Heptachlor was applied in granular form in May 1969 to provide control. Heptachlor is not approved for use on alfalfa by growers.

A moderately weevil resistant variety like Team should be used as a part of an integrated control program including good crop management and judicious use of insecticides when necessary. It is assumed that such varieties will require less frequent use of insecticides, which may result in greater numbers of predators and parasites, and improved biological control of the weevil.

Kinds of Resistance

The weevil resistance of Team is attributed to a combination of factors: tolerance, nonpreference, and antibiosis. Greater tolerance to larval feeding, fewer eggs deposited in stems, and slightly slower larval growth are at present considered the primary factors for improved weevil resistance of Team.

Tolerance.--The inherent capacity of a plant to withstand and recover from insect damage is tolerance. Team has well developed axillary buds and can continue growth after the terminal stem bud is destroyed by larval feeding (fig. 5). It has good spring growth and heavy stem terminals. These characteristics seem to give Team a greater capacity to withstand weevil feeding and to recover than other varieties.

Nonpreference.--Adult weevils preferred Cherokee to Team in laboratory feeding tests (table 6 and fig. 5). Team was also less preferred for egg laying in greenhouse tests. Table 7 shows that improved resistance to oviposition was obtained without sacrificing stem size. The contribution of nonpreference resistance in the laboratory and greenhouse to better performance under field conditions has not been determined.

Antibiosis.--In two laboratory experiments at Beltsville, Md., (table 8) and one conducted in the field at Raleigh, N.C., (table 9) larvae grew somewhat slower on Team than on other varieties. In one test, fewer larvae survived (table 8). The presence of the antibiosis type of resistance in Team, however, has not been definitely established. In field studies at Beltsville and Clarksville, Md., and State College, Pa., Team tended to have fewer larvae per stem than Cherokee, Saranac, and Vernal, but the differences were small and significant only at the 20-percent level of probability (table 10).

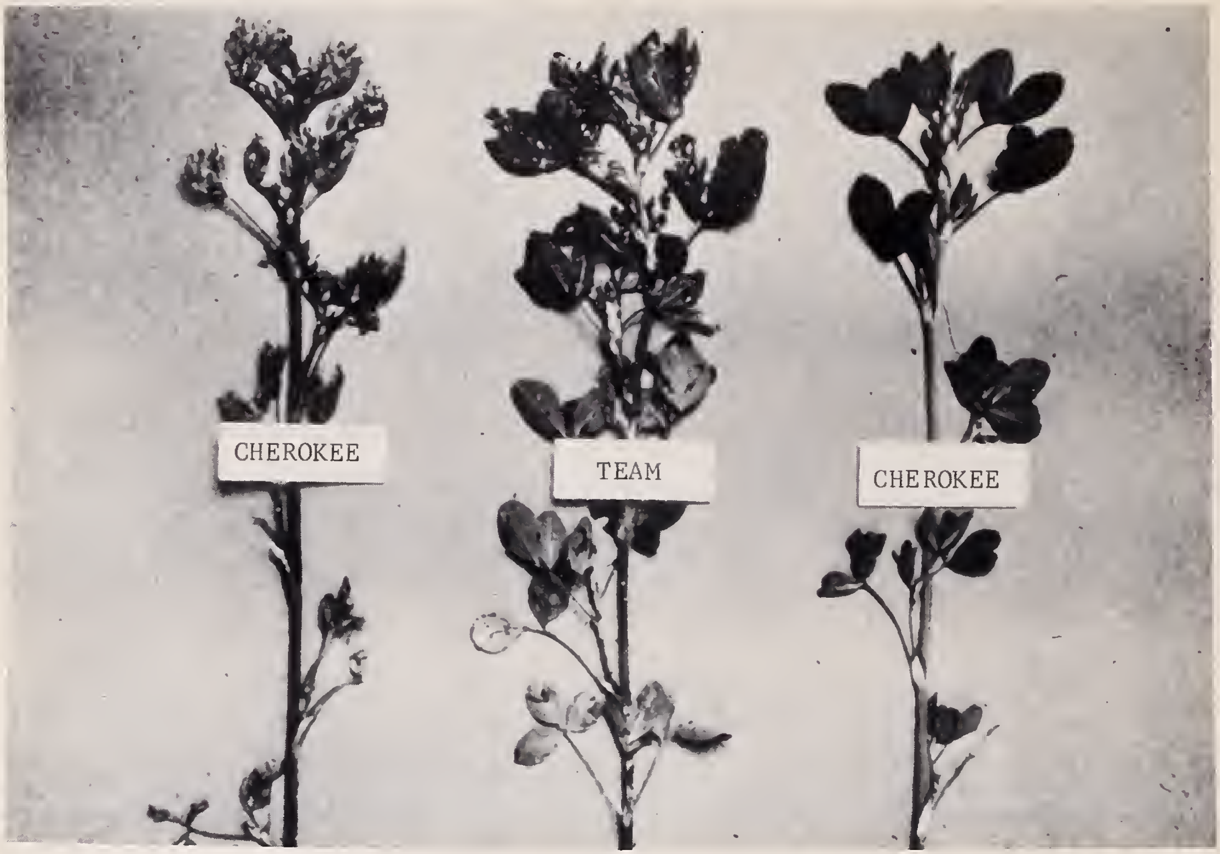


Figure 5.--Left to right, Cherokee and Team, untreated, and Cherokee, treated with heptachlor for weevil control. Team had less feeding and greater development of terminal and axillary stem than Cherokee.

TABLE 6.--Preference feeding of adult alfalfa weevils on Team and Cherokee alfalfa as indicated by seedling survival in 4 cotyledon tests, Beltsville, Md.

	Percentage of seedlings surviving weevil feeding				
	Test				
Variety	1[1]	2[1]	3[1]	4[2]	Av.
Team	34.2	50.3	44.0	59.0	46.9
Cherokee	15.6	32.9	29.4	26.0	26.0
L.S.D. (0.05)	4.2	7.1	6.2	14.5	--

[1] About 90 seedlings per replication, 15 replications.
[2] About 90 seedlings per replication, 3 replications.

TABLE 7.--Stem characteristics of alfalfa varieties as related to egg laying preference of the alfalfa weevil in greenhouse tests, Raleigh, N.C.

Variety	Stem		No. of egg masses	
	Diameter	Length (longest stem)	Per cm. of major stem	Per stem
Team	1.35	35	0.22	6.95
DuPuits	1.30	33	.26	7.66
Williamsburg	1.31	35	.28	8.95
Cherokee	1.36	35	.29	8.71
Atlantic	1.29	36	.27	8.57
Vernal	1.13	33	.25	6.91
L.S.D. (0.05)	.08	N.S.	.04	1.41

TABLE 8.--Antibiosis of alfalfa varieties to larval development as determined by larval size (weight) and survival after 8 days of feeding on respective varieties in laboratory tests, Beltsville, Md.

Variety	8-day larval development					
	Larval weight			Larval survival		
	1968[1]	1969[2]	Av. 2 yr.	1968[1]	1969[2]	Av. 2 yr.
	Mg.	Mg.	Mg.	Pct.	Pct.	Pct.
Team	5.47	6.34	5.91	62	51	56.5
Atlantic	6.46	6.81	6.64	66	58	62.0
Cherokee	7.11	6.97	7.04	70	57	63.5
Vernal	6.76	6.74	6.75	67	58	62.5
L.S.D. (0.05)	.70	.56	--	8	6	--

[1] Twelve 4-plant replications.

[2] Twelve 6-plant replications.

TABLE 9.--Relationship between alfalfa weevil defoliation of alfalfa varieties and weight of stem terminal, number of larvae, and size of larvae in field test No. A-170, 1969, Raleigh, N.C.

Variety	Weight per stem terminal, 4-9-69	No. of larvae per terminal 4-9-69	No. of larvae per terminal 4-17-69	Weight per larva, 4-17-69	Defoliation by larvae, 4-23-69
	G.	No.	No.	G.	Pct.
Team	0.183	4.9	11.0	2.72	28
Atlantic	.164	4.6	9.3	3.53	68
Cherokee	.165	5.5	8.7	3.44	60
DuPuits	.203	6.5	12.1	3.16	45
Vernal	.167	4.6	6.3	3.82	80
Williamsburg	.170	5.5	10.6	2.95	70
L.S.D. (0.05)	.020	1.5	2.2	.84	14

TABLE 10.--Number of alfalfa weevil larvae per stem on alfalfa varieties in 4 tests at 3 locations

	Number of alfalfa weevil larvae per stem				
	Clarksville, Md.		Beltsville,	State College,	
Variety	Test 1 5-6-68	Test 2 5-22-68	Md., 6-3-69	Pa., 5-26-69	Mean of 4 tests
Team	0.90	0.55	1.18	0.44	0.77
Cherokee	.93	1.00	1.67	.42	1.01
Saranac	1.29	.92	1.40	.56	1.04
Vernal	.96	.83	.98	.72	.87
L.S.D. (0.20)	.17	.27	.45	N.S.	.23
L.S.D. (0.10)	.22	.36	.58	N.S.	N.S.
L.S.D. (0.05)	.26	.44	.70	N.S.	N.S.

Resistance to Pea Aphids

Resistance of Team to the pea aphid, *Acyrthosiphon pisum* (Harris), is high and similar to that found in the new resistant varieties Kanza and Dawson (table 11). In Maryland, results of a study on pea aphid numbers in 0.33-acre plots of Team, WL 303, and Williamsburg alfalfas over a 3-week period are shown in table 12. The number of aphids on Team was significantly lower than the number on Williamsburg throughout the period and lower than WL 303 at the end of the period. This substantiated earlier test data from smaller test plots at Beltsville and Clarksville, Md., and from greenhouse tests in Kansas and Nebraska (table 11).

Pea aphid resistance may contribute significantly to better fall and spring growth, and to better color and retention of leaves during periods of infestation.

Resistance to Other Insect Pests

Team was highly susceptible to four biotypes of the spotted alfalfa aphid, *Therioaphis maculata* (Buckton), (table 13). This is not an important consideration in forage production in Eastern United States; but it does add to the cost of seed production, if seed is produced where the aphid is a problem.

Team was slightly more resistant to yellowing caused by potato leafhopper, *Empoasca fabae* (Harris), than Atlantic and Williamsburg in Virginia tests, but yellowing differences among these varieties in Maryland tests were not significant (table 14). In all tests, Team was more susceptible to leafhopper yellowing than Cherokee, which was bred for resistance.

Disease Resistance

Leaf diseases.--Disease resistance evaluations have indicated that Team is moderately resistant to Stemphylium leaf spot, *Stemphylium botryosum* Wallr., common leaf spot, *Pseudopeziza medicaginis* (Lib.) Sacc., and to downy mildew, *Peronospora trifoliorum* D. By., (table 15).

Anthracnose.--Team has a higher level of resistance to anthracnose, *Colletotrichum trifolii* Bain & Essary, than most other available varieties. Approximately 15 to 20 percent of the plants in Team are highly resistant (table 16). Anthracnose is an important disease of alfalfa in the Middle Atlantic area and Southeastern United States (Ostazeski, Barnes, and Hanson, 1969). Barnes, Ostazeski, Schillinger, and Hanson (1969) found that the resistance of Team resulted in improved stands, persistence, and yield (table 17).

Sclerotinia crown and stem rot.--Team, as most varieties, is moderately susceptible to crown and stem rot, caused by *Sclerotinia trifoliorum* Eriks. (table 15).

TABLE 11.--Pea aphid resistance of alfalfa varieties under natural field infestation at Beltsville and Clarksville, Md., and controlled greenhouse infestation at Manhattan, Kans., and Lincoln, Nebr.

	Beltsville, Md.		Clarksville, Md.,		Manhattan, Kans.,	Lincoln, Nebr.,
	Aphid injury,	Aphids per 18-in. row,	Aphids per 10 sweeps		Seedling survival,	Aphid injury,
Variety	10-16-68	10-17-68	9-6-69	9-26-69	6-9 to 6-21-69	1-2 to 1-22-69
	Score[1]	No.[2]	No.[3]	No.[3]	Pct.[4]	Score[5]
Team	1.9	133	20	201	76.5	2
Atlantic	3.0	350	--	--	--	--
Buffalo	--	--	--	--	1.5	5
Cherokee	3.5	394	91	660	--	--
Dawson	--	--	--	--	54.0	1
DuPuits	--	--	--	--	38.0	--
Kanza	--	--	--	--	78.8	1
Saranac	2.7	255	38	307	--	--
Vernal	3.8	346	--	--	--	--
Weevlchek	3.3	234	101	510	--	3
Williamsburg	2.8	312	143	772	--	--
WL 303	--	--	58	393	--	--
L.S.D. (0.05)	1.3	152	32	170	5.6	1

[1] Scored 1-7: 1 = no injury, 7 = severe injury. Six replications.

[2] Total live aphids plus diseased and parasitized aphids from three 6-in. samples of alfalfa cut from center of 3-row plot. Six replications.

[3] Plots 10 x 20 ft., 16 replications on 9-6-69 and 8 replications on 9-26-69.

[4] Four 50-plant replications.

[5] Scored 1-5: 1 = resistant, 5 = susceptible. 1-row plots, 3 replications.

TABLE 12.--Pea aphid resistance of alfalfa varieties as determined by buildup of aphids during 3-week period in 0.33-acre plots, Clarksville, Md.

Variety	Average number of aphids per 50 sweeps[1]		
	8-28-69	9-6-69	9-16-69
Team	28	78	207
WL 303	78	296	861
Williamsburg	260	762	1,135
L.S.D. (0.05)	48	262	316

[1] Plots 95 x 155 ft., 5 replications. Two 50-sweep samples per plot.

TABLE 13.--Spotted aphid resistance of alfalfa varieties in greenhouse tests

	Tucson, Ariz. (1969)[1]					Lincoln, Nebr. (1969)[2]
	Resistance reaction to 4 aphid biotypes				Av.	Resistance
Variety	ENT-A	ENT-C	ENT-E	ENT-F	rating	reaction
Team	HS	HS	HS	HS	HS	5.0
Buffalo	--	--	--	--	--	5.0
Cody	MR	LRI	MR	LRI	MR	--
Dawson	LRI	LRI	MR	MR	MR	1.0
Kanza	MR	HR	MR	MR	MR	1.0
Weevlchek	--	--	--	--	--	4.7
L.S.D. (0.05)	--	--	--	--	--	.4

[1] Rating key: HR = high resistance, MR = moderate resistance, LRI = low resistance (intermediate), S = susceptible, and HS = high susceptibility.

[2] Scored 1-5: 1 = resistant, 5 = susceptible. Biotypes undetermined.

TABLE 14.--Leafhopper yellowing scores of and leafhopper counts on alfalfa varieties in field tests, Blacksburg, Va., Beltsville and Clarksville, Md.

	Leafhopper yellowing score		No. of leafhoppers per 50 sweeps[3]
Variety	Blacksburg, Va., 7-10-68[1]	Beltsville, Md., 7-16-68[2]	Clarksville, Md., 8-12-69
Team	4.1	3.6	83
Atlantic	5.7	4.3	--
Cherokee	2.2	2.7	--
Saranac	3.0	3.2	--
Vernal	3.2	4.0	--
Williamsburg	6.6	4.7	101
WL 303	--	--	86
L.S.D. (0.05)	.8	2.1	N.S.

[1] Scored 1-9: 1 = green, 9 = yellow. Six replications, plots 5 x 20 ft.

[2] Scored 1-9: 1 = green, 9 = yellow. Six replications, plots 3 x 16 ft.

[3] Five replications, plots 95 x 155 ft.

TABLE 15.--Foliar disease scores of alfalfa varieties

Variety	Foliar disease, Beltsville, Md.		*Stemphylium* leaf spot, Clarksville, Md.,	Downy mildew			*Sclerotinia*, Salisbury, N.C.	
	10-22-68[1]	9-5-69[2]	9-18-67[3]	Manhattan, Kans., 6-5-69[3]	Blacksburg, Va., 6-24-69[4]	St. Paul, Minn., 10-15-69[5]	Test 2 3-18-69[6]	Test 3 3-18-69[6]
Team, MSHp7	3.2	2.3	--	4.2	3.0	77	2.7	2.2
MSHp6[7]	3.3	2.3	2.6	--	--	--	--	--
Atlantic	5.7	4.0	--	--	--	--	--	--
Buffalo	--	--	--	5.5	--	--	--	--
Cherokee	3.5	2.7	2.3	3.2	2.0	--	3.0	3.0
Cody	--	--	--	6.0	--	--	--	--
Dawson	--	--	--	6.0	--	--	--	--
Delta	--	--	--	--	--	--	--	3.3
DuPuits	--	--	--	3.8	--	--	2.7	2.2
Florida 66	--	--	--	--	--	--	--	5.0
Iroquois	--	--	2.7	--	--	89	--	3.0
Kanza	--	--	--	6.0	--	--	--	--
Saranac	3.0	3.2	2.5	2.5	2.0	93	--	3.0
Vernal	6.5	3.3	3.8	--	--	60	1.8	--
Weevlchek	6.8	3.5	--	--	2.8	72	2.0	1.8
Williamsburg	4.7	4.5	--	--	4.8	--	--	--
L.S.D. (0.05)	.6	.7	.2	.6	.6	18	.8	.7

[1] Scored 1-9: 1 = none, 9 = severe defoliation. Score represents combination of common and *Stemphylium* leaf spots.

[2] Scored 1-5: 1 = none, 5 = severe yellowing. Several pathogens were implicated, but identity and relative importance were not established.

[3] Scored 1-9: 1 = none, 9 = severe infection.

[4] Scored 1-5: 1 = none, 5 = severe infection.

[5] Percent resistant plants.

[6] Scored 1-5: 1 = 5% dead plants, 5 = 25% dead plants.

[7] MSHp6 = generation before MSHp7 (Team).

TABLE 16.--Percentage of plants in alfalfa varieties classified as resistant to anthracnose in 6 growth chamber tests, Beltsville, Md.

	Percentage of resistant plants when inoculated as--[1]					
	2- or 4-week-old seedlings					Mature plants,
Variety	11-24-67	7-22-68	9-11-68	9-30-68	10-14-68	2-26-68
Team	17.9	14.9	16.2	21.3	18.6	25.0
Cherokee	15.0	14.9	--	5.4	5.5	12.5
Dawson	--	.7	2.2	--	.1	--
DuPuits	8.0	--	--	.9	2.2	9.4
Iroquois	3.8	1.8	.8	1.4	2.9	--
Saranac	5.4	4.1	.0	--	1.4	--
Vernal	7.8	2.3	--	--	4.4	6.3
Williamsburg	--	6.3	--	1.3	5.1	--

[1] Number of plants evaluated per variety per test: 11-24-67, 375; 7-22-68, 150; 9-11-68, 120; 9-30-68, 75; 10-14-68, 100; and 2-26-68, 32.

TABLE 17.--Anthracnose damage scores of alfalfa varieties as related to subsequent loss of stands, Clarksville, Md.

	Anthracnose[1]		Stand reduction[2] by--		Ground cover,
Variety	9-18-67	8-1-68	4-2-68	4-9-69	7-14-69
	Score	Score	Pct.	Pct.	Pct.
Team, MSHp6[3]	2.9	4.3	13	36	56
Cherokee	3.1	4.6	17	48	44
Iroquois	4.7	7.4	28	63	33
Saranac	4.9	7.4	19	54	38
Vernal	3.6	5.6	39	58	36
L.S.D. (0.05)	1.3	1.7	11	9	11

[1] Scored 1-9: 1 = none, 9 = severe damage; 20 replications.

[2] Percent stand reduction based on percent stand on 7-10-67 (70 days after seeding); 20 replications.

[3] MSHp6 = generation before MSHp7 (Team).

Bacterial wilt.--Team is susceptible to bacterial wilt, Corynebacterium insidiosum (McCull.) H. L. Jens., (table 18). Bacterial wilt, however, is not a serious disease problem of alfalfa in the Maryland-Virginia-North Carolina area. Susceptibility to this disease will limit production of Team outside of the Middle Atlantic States where wilt is a problem.

TABLE 18.--Bacterial wilt scores of alfalfa varieties from field test, St. Paul, Minn.

Variety and test year	Percentage of plants in score classes[1]						Severity index[1]
	0	1	2	3	4	5	
Team							
1967[2]	1.9	1.3	3.8	13.4	66.2	13.4	3.81
1968	.2	.0	1.0	14.6	66.6	17.7	4.00
1969	.1	.3	1.5	7.2	51.5	39.4	4.28
Narragansett							
1967	1.3	.7	3.7	15.7	48.4	30.3	4.00
1968	.7	.7	.7	1.4	36.6	59.9	4.52
1969	.0	.5	.0	3.6	44.6	51.3	4.46
Ranger							
1967	15.0	14.4	13.8	21.0	31.8	3.9	2.52
1968	2.8	8.7	10.1	22.9	44.8	10.8	3.31
1969	5.9	10.5	12.8	25.6	36.5	8.7	3.04
Vernal							
1967	37.2	14.2	8.2	13.1	23.7	3.6	1.83
1968	26.2	18.2	10.7	13.8	28.0	3.1	2.09
1969	15.3	22.3	16.6	24.0	20.5	1.3	2.17

[1] Scored 0-5: 0 = no symptoms, 5 = dead. Three replications of 55 to 120 plants each.

[2] MSHp6, the generation before MSHp7 (Team), was tested in 1967.

Cold Hardiness

Stands of Team and earlier cycles of this population at Beltsville, Md., did not suffer because of cold injury during 1960 to 1969. Team survived two winters at State College, Pa. This variety appears to be sufficiently hardy for the Maryland-Virginia-North Carolina area except perhaps at higher elevations in the mountains. Further information is being obtained from tests now in progress outside of the three-State area.

Seedling Vigor

Seedling vigor of Team was similar to presently available varieties. In North Carolina where most plantings have been made in the fall, seedling growth of Team has compared very favorably with the most vigorous varieties in the test. Observations made at Clarksville, Md., suggest that Team may be more sensitive to applications of the pre-emergence herbicide Eptam than other varieties.

Recovery After Cutting

We have observed that recovery after cutting of Team is markedly slower than most varieties except Vernal for at least 1 week after cutting. However, Team then grows vigorously and will equal or even surpass most varieties in plant height by harvest (table 19). Team and Saranac reach 1/10th bloom several days earlier than varieties such as Atlantic, Vernal, and Iroquois (table 20). Early flowering behavior was also observed in Minnesota and Utah tests.

Fall Growth

Fall growth of Team is approximately the same as Saranac and Cherokee (table 21). It has a degree of frost tolerance that is less than that in Cherokee but greater than that available in most other varieties (table 22). This may permit later fall growth.

Spring Vigor

Spring vigor of Team in the Maryland-Virginia-North Carolina area is exceptional (table 23). It begins growth early in the spring and continues vigorous growth until harvest. Vigorous spring growth may impart some tolerance to the alfalfa weevil. In addition to good spring vigor, Team has large stem terminals (fig. 5) and more axillary branching at stem nodes than other varieties. Both large stem terminals and axillary branching may contribute to high yields even when the alfalfa weevil is not a problem.

TABLE 19.--Recovery of alfalfa varieties after cutting, determined as plant height (centimeters)

Variety	2 to 3 weeks after cutting[1]			4 weeks after cutting,[1]		
	Beltsville, Md.,	Raleigh, N.C.		Raleigh, N.C.		
		Test 1	Test 2	Test 1	Test 1	Test 2
	8-6-68	7-25-67	5-29-68	6-27-67	8-20-68	8-20-68
Team, MSHp7	27.8	--	27.2	--	--	35.0
MSHp6[2]	--	38.2	--	40.8	39.5	--
Atlantic	30.5	37.5	26.6	35.0	38.7	35.0
Cherokee	26.6	35.5	26.1	36.8	39.7	32.0
DuPuits	--	34.5	29.7	35.7	37.7	38.2
Saranac	27.8	--	--	--	--	--
Vernal	25.8	36.2	24.6	35.5	36.2	32.7
Williamsburg	27.0	40.3	27.2	37.7	41.8	37.0
L.S.D. (0.05)	3.7	3.6	2.6	3.1	2.8	3.3

[1] Six replications.

[2] MSHp6 = generation before MSHp7 (Team).

TABLE 20.--Comparative maturity of alfalfa varieties as determined by bloom

Variety	Stage of maturity		
	Blacksburg, Va.,	Clarksville, Md.[1]	
	7-10-68	7-6-67	8-1-68
	Pct. bloom	Score	Score
Team[2]	6.3	3.4	7.0
Atlantic	3.7	--	--
Cherokee	4.7	3.1	6.8
Iroquois	--	2.7	6.2
Saranac	7.7	3.4	7.3
Vernal	4.0	1.9	5.5
Williamsburg	2.7	--	--

[1] Scored 1-8: 1 = no bloom (vegetative), 8 = full bloom.

[2] Clarksville data taken on MSHp6. MSHp6 = generation before MSHp7 (Team).

TABLE 21.--Fall growth scores of alfalfa varieties at 5 locations

Variety	Bedford, Ind., 9-30-68[1]	Beltsville, Md., 10-16-68[1]	Clarksville, Md., 10-16-67[2]	Raleigh, N.C., 11-13-68[3]	Arlington, Wis., 9-2-68[4]
Team, MSHp7	3.5	3.9	--	5.4	3.0
MSHp6[5]	--	3.5	2.1	--	--
Atlantic	4.6	5.3	--	6.8	--
Cherokee	3.6	4.8	3.5	4.5	--
DuPuits	--	--	--	2.2	1.8
Iroquois	--	--	5.4	--	5.1
Saranac	4.0	3.5	4.0	--	2.7
Vernal	5.3	7.8	5.4	7.6	6.6
Weevlchek	5.0	5.7	--	--	5.2
Williamsburg	--	5.7	--	3.0	--
L.S.D. (0.05)	1.1	1.9	1.2	1.2	1.2

[1] Scored 1-9: 1 = most growth, 9 = least growth, 6 replications.

[2] Scored 1-9: 1 = most growth, 9 = least growth, 20 replications.

[3] Scored 1-9: 1 = most growth, 9 = least growth, 6 replications.

[4] Scored 1-9: 1 = most growth, 9 = least growth, 4 replications.

[5] MSHp6 = generation before MSHp7 (Team).

TABLE 22.--Defoliation of alfalfa varieties from frost damage, Raleigh, N.C.

Variety	Percentage of defoliation 11-23-67	 12-9-68
Team, MSHp7	--	31
MSHp6[1]	64	--
Atlantic	88	42
Buffalo	90	--
Cherokee	55	21
DuPuits	42	42
Vernal	85	45
Williamsburg	90	47
L.S.D. (0.05)	4.7	7.0

[1] MSHp6 = generation before MSHp7 (Team).

TABLE 23.--Spring vigor of alfalfa varieties at 6 locations

	Spring vigor							
					Raleigh, N.C.			
Variety	Bedford, Ind., 4-29-69	Blacksburg, Va., 4-30-69	Clarksville, Md., 4-23-68	Beltsville, Md., 5-5-69	Test 1 4-1-68	Test 2 4-1-68	Test 2 4-8-69	State College, Pa., 5-12-69
	Score[1] [2]	Score[1] [2]	Cm.[3]	Cm.[2]	Cm.[2]	Cm.[2]	Cm.[2]	Cm.[4]
Team	2.3	2.2	[5]41.3	50.2	[5]24.2	23.3	26.3	41.0
Atlantic	3.4	3.2	--	48.3	19.2	21.3	23.7	--
Cherokee	2.8	3.8	38.3	46.4	20.8	20.3	23.5	38.4
DuPuits	--	--	--	--	19.2	23.7	27.8	--
Iroquois	--	--	35.8	--	--	--	--	--
Saranac	2.3	1.0	39.7	49.6	--	--	--	41.0
Vernal	4.5	3.0	30.1	42.6	18.8	18.5	20.8	37.8
Weevlchek	3.2	--	--	44.7	--	--	--	--
Williamsburg	--	3.3	--	43.4	20.8	20.5	24.3	--
L.S.D. (0.05)	1.6	.6	2.0	3.7	2.6	1.9	1.4	1.4

[1] Scored 1-5: 1 = most growth, 5 = least growth.

[2] Six replications.

[3] Twenty-four replications.

[4] Thirty replications.

[5] Obtained on MSHp6 (generation before MSHp7 = Team).

Hay Yields

Hay yields of Team were generally higher than those of other varieties adapted to the Maryland-Virginia-North Carolina area. Yields (about 12-percent moisture) are given in tables 24 to 30, inclusive.

In North Carolina (tables 24 and 25), yield superiority was evident primarily in the first cutting of each season. This was attributed mostly to weevil resistance. In Maryland (tables 26 to 28), the relative yield of Team generally increased with age of stand. This was attributed to greater persistence. In Virginia (tables 29 and 30), where yield data were more limited, Team significantly exceeded Cherokee and Vernal in the first full year of yield data.

The yield performance of Team is also being determined at many locations outside of the three-State area. However, the data are too preliminary to judge its adaptability in other areas.

TABLE 24.--Hay yields of alfalfa varieties in test No. A-160, Raleigh, N.C.[1]

	Tons per acre							
	1967					1968[2]		
Variety	5-29	7-7	8-2	9-18	Total	6-13	7-24	Total
Team, MSHp6[3]	1.39	1.20	1.09	1.36	5.04	1.15	1.26	2.41
Atlantic	.75	.97	.87	1.22	3.81	1.02	1.18	2.20
Buffalo	.82	.91	.85	1.20	3.78	.85	1.07	1.92
Cherokee	1.09	1.05	.95	1.23	4.32	1.08	1.24	2.32
DuPuits	.63	.92	.76	1.17	3.48	1.01	1.20	2.21
Vernal	1.32	1.16	1.04	1.23	4.75	1.06	1.15	2.21
Williamsburg	.82	.99	.94	1.24	3.99	.92	1.19	2.11
L.S.D. (0.05)	.21	.16	.16	.16	.59	.10	.12	.20

[1] Plots established 9-15-66; 2.5- x 15-ft. plots planted in 3 drilled rows, 6 replications.

[2] Severe weevil infestation; no insecticide applied before harvest; stubble treated at harvest. Yield of first cut was not determined. Fourth cut was not obtained because of drought.

[3] MSHp6 = generation before MSHp7 (Team).

TABLE 25.--Hay yields of alfalfa varieties in test No. A-170, Raleigh, N.C.[1]

	Tons per acre							
	1968					1969		
Variety	5-6	6-13	7-24	9-3[2]	4-cut total	6-23[3]	8-21	2-cut total
Team	1.18	1.13	1.18	0.47	3.96	2.08	2.12	4.20
Atlantic	1.07	1.15	1.19	.52	3.93	1.82	2.29	4.11
Cherokee	.92	1.11	1.23	.46	3.72	1.73	2.20	3.93
DuPuits	1.07	1.01	.95	.48	3.51	1.93	1.88	3.81
Vernal	.87	1.10	1.03	.38	3.38	1.78	2.00	3.78
Williamsburg	.78	1.02	1.25	.52	3.57	1.73	2.14	3.87
L.S.D. (0.05)	.15	.13	.15	.11	.46	.13	.18	.32

[1] Plots established 9-12-67; 2.5- x 15-ft. plots planted in 3 drilled rows, 6 replications.

[2] Yield reduced because of drought.

[3] Yields from 1st and 3d cuts were not determined.

TABLE 26.--Hay yields of alfalfa varieties in 1967 Management Test, Clarksville, Md.[1]

	Tons per acre														
	Seedling year, 1967[2]			1968					1969					
Variety	8-15	10-10	Total	5-22	6-21	8-1	9-12	Total	5-12	6-13	7-14	8-14	9-11	Total
Team, MSHp6[3]	1.09	0.80	1.89	2.20	1.30	1.60	0.95	6.05	2.19	1.57	1.21	1.38	1.00	7.35
Cherokee	1.06	.77	1.83	2.15	1.22	1.56	.98	5.91	1.83	1.45	1.07	1.29	.95	6.59
Iroquois	1.05	.67	1.72	2.00	1.23	1.48	.89	5.60	1.79	1.50	1.01	1.13	.91	6.34
Saranac	1.11	.74	1.85	2.10	1.28	1.48	.86	5.72	1.83	1.42	.99	1.12	.92	6.28
Vernal	1.06	.50	1.56	1.89	1.12	1.42	.95	5.38	1.76	1.35	1.03	1.26	.92	6.32
L.S.D. (0.05)	.05	.05	.07	.21	.12	.21	.14	.29	.09	.21	.16	.13	.14	.09

[1] Plots established 4-25-67; 5- x 20-ft. broadcast plots, 20 replications.

[2] First crop removed without recording weight.

[3] MSHp6 = generation before MSHp7 (Team).

TABLE 27.--Hay yields of alfalfa varieties in 1968 Management-Fertility-Interaction Study, Clarksville, Md.[1]

	Tons per acre								
	Seedling year, 1968			1969					
Variety	7-10	8-21	Total	5-14	6-13	7-14	8-12	9-11	Total
Team	1.03	0.29	1.32	2.30	1.46	0.75	1.55	0.91	6.96
Cherokee	.95	.33	1.28	2.10	1.48	.84	1.61	1.04	7.06
Saranac	1.01	.32	1.33	2.06	1.62	.84	1.17	.77	6.46
Weevlchek	1.01	.19	1.20	2.05	1.39	.74	1.58	1.02	6.78
Williamsburg	.93	.23	1.16	1.96	1.53	.83	1.51	1.06	6.89
WL 303	.94	.29	1.23	1.89	1.55	.84	1.33	.89	6.49
L.S.D. (0.05)	N.S.	N.S.	N.S.	.29	.18	.17	.21	.07	.33

[1] Plots established 4-17-68; 6- x 20-ft. broadcast plots, 16 replications.

TABLE 28.--Hay yields of alfalfa varieties in 1968 Management Test, Clarksville, Md.[1]

	Tons per acre, 1969				
Variety	5-22	6-24	8-13	9-11	Total
Team	2.16	1.40	1.63	0.98	6.17
Cherokee	1.96	1.34	1.63	1.00	5.93
Saranac	1.99	1.52	1.56	.94	6.02
Vernal	1.86	1.36	1.62	.92	5.76
L.S.D. (0.05)	.08	.09	N.S.	.06	.20

[1] Plots established 4-17-68; 5- x 20-ft. broadcast plots, 30 replications.

TABLE 29.--Hay yields of alfalfa varieties, Blacksburg, Va.[1]

	Tons per acre							
	Seedling year, 1968			1969				
Variety	7-10	8-28	Total	5-29	7-2	8-5	9-15	Total
Team	1.58	2.23	3.81	1.89	0.99	0.64	1.06	4.58
Atlantic	1.53	2.20	3.73	1.57	1.00	.73	1.02	4.32
Cherokee	1.52	2.20	3.72	1.49	.87	.66	.96	3.98
Saranac	1.67	2.22	3.89	1.74	1.12	.80	1.14	4.80
Vernal	1.64	2.18	3.82	1.51	.93	.65	.95	4.04
Williamsburg	1.39	2.12	3.51	1.44	.99	.78	1.12	4.33
L.S.D. (0.05)	.10	N.S.	.18	.18	N.S.	.11	.13	.52

[1] Plots established 4-16-68; 5- x 20-ft. broadcast plots, 6 replications.

TABLE 30.--Seedling year hay yields of alfalfa varieties from 1969 Management Test at 2 Virginia locations[1]

	Tons per acre					
	Blacksburg[2]			Orange[3]		
Variety	8-8	9-17	Total	7-15	8-13	Total
Team	0.95	1.30	2.25	1.08	1.08	2.16
Cherokee	.91	1.19	2.10	.95	1.11	2.06
Narragansett	.93	1.10	2.03	1.12	1.12	2.24
Saranac	.94	1.23	2.17	1.32	1.05	2.37
Weevlchek	.83	1.21	2.04	1.06	1.10	2.16
Williamsburg	.83	1.09	1.92	1.11	1.18	2.29
L.S.D. (0.05)	.09	.13	.19	.18	N.S.	N.S.

[1] Six replications of 5- x 20-ft. broadcast plots.

[2] Plots established 4-21-69.

[3] Plots established April 1969.

Forage Quality

Forage quality of Team was evaluated by chemical analysis and feeding experiments before it was released as a variety. Two sets of chemical determinations were made on hay harvested from small plots (5 x 20 ft.). The results from both tests indicated that chemical components were similar to those found in other varieties (tables 31 and 32).

A more extensive trial was conducted to measure both animal performance and chemical composition. These trials were conducted by the University of Maryland on varieties Team, WL 303, and Williamsburg. Each variety was established in 0.33-acre plots with five replications. Hay yields were determined as total dry matter removed from each plot by conventional farm harvesting equipment and hay was fed to yearling Holsteins. Differences in intake of hay of the three varieties were statistically significant but small (table 33). Neither digestibility coefficients nor animal performance differed significantly for varieties (tables 34 and 35). The data indicate that resistance of Team to disease and insect pests did not reduce nutritional qualities of the forage.

TABLE 31.--Forage quality components for hay of alfalfa varieties in 1967 Management Test, Clarksville, Md.[1]

Variety	Percentage of DMD[2] (6 hr. in vitro rumen ferment)	Forage quality components[2]					
		CWC	ADF	Lignin	Cellulose	Ash	D. app.
MSHp6[3]	38.3	36.3	30.3	8.9	20.8	0.45	63.4
Cherokee	36.0	38.3	31.0	9.1	21.4	.59	62.4
Iroquois	37.0	36.9	29.9	8.9	20.9	.44	62.9
Saranac	38.0	38.7	29.8	9.0	20.2	.71	61.8
Vernal	37.1	38.6	32.3	9.4	22.2	.72	62.2

[1] Harvested 8-15-67.

[2] DMD = dry matter digestibility, CWC = cell wall constituent, ADF = acid detergent fiber, and D. app. = apparent digestibility.

[3] MSHp6 = generation before MSHp7 (Team).

TABLE 32.--Percentage of cell wall cellulose of alfalfa varieties in 1967 Management Test on each of 2 harvest dates, Clarksville, Md.

Variety	Percentage of cell wall cellulose at two stages of growth: Very early bud, 5-6-68	Percentage of cell wall cellulose at two stages of growth: 1/10 bloom, 5-22-68
MSHp6[1]	39.6	39.2
Cherokee	40.8	37.9
Iroquois	39.6	38.1
Saranac	39.3	38.6
Vernal	39.8	38.1
L.S.D. (0.05)	.94	.96

[1] MSHp6 = generation before MSHp7 (Team).

TABLE 33.--Dry matter intake of yearling Holstein steers fed hay of alfalfa varieties[1]

Variety and cutting	Intake: Percentage of body weight	Intake: Kg. per 100 kg. metabolic size
1st cutting:		
Team	2.18	8.75
Williamsburg	2.00	7.96
WL 303	2.09	8.32
2d cutting:		
Team	2.33	9.28
Williamsburg	2.21	8.99
WL 303	2.10	8.48

[1] Alfalfa varieties were seeded 4-17-68, Clarksville, Md., in 0.33-acre plots, 5 replications. First and 2d cuttings used in feeding trials were harvested 7-11-68 and 9-1-68, respectively.

TABLE 34.--Yield and digestibility coefficients of hay from alfalfa varieties[1] used in feeding trial

Variety and cutting	Hay yield per acre	Digestibility coefficients				
		DM[2]	CWC[3]	ADF[4]	Cellulose	Hemicellulose
	Tons	Pct.	Pct.	Pct.	Pct.	Pct.
1st cutting:						
Team	1.80	54.8	43.6	41.9	54.9	50.9
Williamsburg	1.57	53.1	41.9	41.9	55.4	42.1
WL 303	1.58	55.3	44.2	42.3	58.1	51.7
2d cutting:						
Team	.59	69.0	52.3	55.2	65.0	38.4
Williamsburg	.53	68.5	49.3	48.6	60.1	51.2
WL 303	.48	70.9	55.7	58.2	66.8	47.8

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[1] Alfalfa varieties were seeded 4-17-68, Clarksville, Md., in 0.33-acre plots, 5 replications. First and 2d cuttings used in feeding trials (see table 33) were harvested 7-11-68 and 9-1-68, respectively.

[2] Dry matter.

[3] Cell wall constituent.

[4] Acid detergent fiber.

TABLE 35.--Chemical composition (on moisture-free basis) of hay of alfalfa varieties[1] used in feeding trial

Variety and cutting	Chemical composition					
	CWC[2]	ADF[3]	Hemi-cellulose	Cellu-lose	Lignin	Ins. ash[4]
	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
1st cutting:						
Team	52.6	42.6	10.0	26.8	12.3	3.1
Williamsburg	53.1	43.3	9.8	28.8	12.7	1.8
WL 303	53.0	41.8	11.2	28.5	11.5	2.3
2d cutting:						
Team	35.2	28.3	6.9	19.7	8.2	.5
Williamsburg	38.2	26.2	8.7	18.9	7.8	.4
WL 303	34.9	29.7	9.0	20.5	8.8	--

[1] Alfalfa varieties were seeded 4-17-68, Clarksville, Md., in 0.33-acre plots, 5 replications. First and 2d cuttings used in feeding trials (see table 33) were harvested 7-11-68 and 9-1-68, respectively.

[2] Cell wall constituent.

[3] Acid detergent fiber.

[4] Insoluble ash.

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